Tektronix
portable oscilloscopes

TEKTRONIX®

committed to technical excellence

Bob Jones 541-2105

PORTABLE OSCILLOSCOPE REFERENCE

PRODUCT	PAGE	STORAGE	BW	DEFLECTION FACTOR	DUAL TRACE	DELAYED SWEEP	SWEEP RATE (WITH MAG)	MAG	BATTERY POWER	DISPLAY SIZE
211	14		500 kHz	10 mV/div @ BW 1 mV/div Min			1 μs/div	X5	Yes	6 x 10 div 0.2 in/div
323	13		4 MHz	10 mV/div @ BW 1 mV/div Min			0.5 μs/div	X10	Yes	6 x 10 div ¼ in/div
324	12		10 MHz	10 mV/div @ BW 2 mV/div Min			0.2 μs/div	X5	Yes	6 x 10 div ¼ in/div
326	11		10 MHz	10 mV/div @ BW 1 mV/div Min	Yes		0.1 μs/div	X10	Yes	8 x 10 div ¼ in/div
422/ R422	10		15 MHz	10 mV/div @ BW 1 mV/div Min	Yes		50 ns/div	X10	Yes	8 x 10 div 0.8 cm/div
432/ R432	8		25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50		8 x 10 cm
434/ R434	8	Yes	25 MHz	10 mV/div @ BW 1 mV/div Min	Yes		20 ns/div	6 steps to X50		8 x 10 div 0.98 cm/div
453A/ R453A	10		60 MHz	20 mV/div @ BW 5 mV/div Min	Yes	Yes	10 ns/div	X10		8 x 10 div 0.8 cm/div
454A R454A	10		150 MHz	10 mV/div @ BW 2 mV/div Min	Yes	Yes	2 ns/div	X10		8 x 10 div 0.8 cm/div
465	6		100 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	5 ns/div	X10	Yes	8 x 10 div 1 cm/div
475	6		200 MHz	2 mV/div @ BW 2 mV/div Min	Yes	Yes	1 ns/div	X10	Yes	8 x 10 div 1 cm/div
485	4		350 MHz	5 mV/div @ BW 5 mV/div Min	Yes	Yes	1 ns/div		Yes	8 x 10 div 0.8 cm/div

The TEKTRONIX family of portable oscilloscopes is designed to solve measurement problems with laboratory precision—in the field or in the lab. These instruments are designed to be carried comfortably in a position which places the front panel in a vertical plane, rather than the horizontal format which is usually used for non-portable oscilloscopes. These ruggedized oscilloscopes will withstand severe environments wherever you go without the additional costs usually associated with militarized instruments.

Beginning with the first TEKTRONIX portable oscilloscope, measurements compromised by adverse field conditions have been significantly reduced. Today, with the availability of these new and improved portables, compromised field measurements are even less likely to occur.

485 The 485 is a 350 MHz, 1 ns/div, 21.5 lb portable dual-trace oscilloscope. In addition to significantly advancing portable measurement capabilities, the 485 has many other new features. These features include selectable input impedance, trigger holdoff, external trigger display, alternate delayed sweep with trace separation control, vertical scale-factor indication, auto-focus, and B sweep intensity control.

The 485 vertical system provides wide bandwidth at full sensitivity with selectable input impedances. At 5 mV/div sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ), the 485 offers more gain bandwidth than any other oscilloscope available today. Selectable input impedance provides the capability to measure high and low impedance points in the same application with the same scope and without special purpose probes.

Sweep rates to 1 ns/div without magnifier complement the high bandwidth. An alternate sweep mode expands the delayed sweep concept in portables. This feature allows the delayed sweep to appear alternately with the intensified main sweep.

465/475 Customer preference made TEKTRONIX Portables the most widely used service and laboratory oscilloscopes in virtually an unlimited range of applications. The reasons are many, including performance and features such as delayed sweep that's easy to use, simplified full-range triggering and other straightforward functions which make oscilloscope operation easy. The 465 and 475 are the newest addition to this growing series of oscilloscopes. A carefully designed front panel provides space for a bright 8 x 10-cm, high-resolution CRT. Properly spaced, logically arranged controls optimze operator learning time. Users will switch quickly and precisely among the many operating modes for positive solutions to complex measurement problems.

The majority of laboratory problems are solved by high-performance, dual-trace oscilloscopes. These are the laboratory measurements which the 465 and 475 will also solve. Their price-performance value offers sound solutions to the majority of laboratory measurements.

324/326 The SONY®/TEKTRONIX® 326 (dual channel) and the SONY®/TEKTRONIX® 324 (single channel) are 10 mV/div oscilloscopes with 10-MHz bandwidth which operate from internal rechargeable batteries, AC or external batteries. The 324/326 extends to 10 MHz the capabilities of the widely used 4-MHz 323. Higher performance solves more measure-

ment problems and with the addition of the 326 these problems are more quickly diagnosed. The small size and power options make the 324/326 ideal for applications where space and power sources are at a premium.

211. This microscope is optimized for field maintenance and other applications where space and portability are primary considerations. Though small, approximately 3.0 lbs., and 3 x 5.3 x 9.5 inches, it is complete. The 211 is the first laboratory-quality microscope. It offers performance and carrying convenience at a lower price than many other 500-kHz scopes. The integral probe and power cord wrap around a recessed area in the case. They are out of the way and the user knows exactly where they'll be when he reaches the next job.

Industrial applications may necessitate "floating" an oscilloscope. The 211 may be elevated to 700 volts above ground when operated from batteries, and 250 volts RMS above ground from AC.

432/434 OSCILLOSCOPES

The 432 and 434 have identical performance characteristics, except the 434 has a bistable storage CRT. These dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div and deflection factors to 1 mV/div cover a wide range of laboratory and field applications. Cabinet height is 5¾ inches including the feet (rackmount height is 5½ inches) and weight is 20¾ pounds.

434 STORAGE OSCILLOSCOPE

The 434 Storage Oscilloscope is virtually two instruments in one. It offers all of the advantages of Bistable Split-Screen Storage, plus those of a conventional oscilloscope in a portable instrument.

Storage has long been a desired characteristic in portable oscilloscopes. Uses for storage continue to expand as electronic equipment uses and costs place stronger demands upon quick isolation and solution of problems. Signals which are single event or low repetition rate, aperiodic or random are usually difficult to measure with a nonstorage oscilloscope. The 434 Oscilloscope provides easy solutions to many of these problems.

Now there is a choice of two storage CRTs; one provides a writing speed of 100 div/ms (400 div/ms enhanced) and the other 500 div/ms (5000 div/ms enhanced).

Split-screen storage operates in each of three modes: full-screen storage, or upper (or lower) screen storage with the other half in a conventional mode. Events stored on the upper (or lower) area are stable reference points for events displayed in a conventional mode on the lower (or upper) area. Thus, amplitude, duration, and other characteristics of waveforms displayed in a conventional mode can be adjusted precisely to the stored reference trace.

TEKTRONIX storage oscilloscopes free the operator to concentrate on the test point rather than the storage controls. To capture aperiodic events the 434 is operated in a store/single sweep mode. When an event occurs, it is stored and retained in a view mode without further operator attention for up to four hours. The user is then free to concentrate on the test point and leave the oscilloscope unattended, confident that when the event occurs it will be displayed in a stored mode for viewing at his convenience. Information may be retained on either half of the CRT when the other half is erased by a push-button control.

RUGGEDIZED PORTABLES

This family of TEKTRONIX oscilloscopes are solid-state instruments that combine small size, light weight and the ability to make precision waveform measurements. As such, these instruments must withstand the shock, vibration, and other extremes of environment associated with portability.

The environmental characteristics of these instruments allow them to operate over a temperature range of −15°C to +55°C and be stored for long periods from −55°C to +75°C. For those instruments including batteries, the storage temperatures are −40°C to +60°C.

These environmentalized instruments will operate at an altitude of 15,000 feet, but can be carried, non-operating, to altitudes as high as 50,000 feet. The effects of high humidity have been minimized since these instruments meet 5 cycles of a test as defined by MIL-STD-202C method 106B, or MIL-E-16400F. Non-nutrient materials are used where possible.

These instruments will withstand vibration for 15 minutes along each of the three major axes, 0.025 inches peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in one-minute cycles, while operating. They will also withstand shock of 30 g's, half sine, 11-ms duration, two shocks per axis in each direction for a total of 12 shocks, operating or non-operating.

Electromagnetic interference (EMI) should be considered in both laboratory and field applications. 400-Series portables have been subjected to tests as specified in MIL-I-6181D where EMI radiated from the instrument is held within the given limits from 150 kHz to 1 GHz. EMI conducted out of the instrument through the power cord is held within the given limits from 150 kHz to 25 MHz. Instruments meeting EMI requirements can be ordered as an option.

BATTERY OPERATION

Eight portables (211, 323, 324, 326, 422, 465, 475 and 485) can be battery operated. The 465, 475 and 485 use the 1105 and 1106 Battery Power Supply. With battery operation, the user moves from one remote location to another without concern for power connections. Battery powered instruments are especially suited for maintenance at sites such as remote microwave installations, mobile communications equipment, aircraft and marine instrumentation and production control equipment.

The nickel cadmium battery cells used in TEKTRONIX instruments have been selected after extensive evaluation. Each battery cell in the battery pack receives an ampere-hour test, has met or exceeds the ampere-hour storage requirement and has been rigidly inspected. The battery cells used in the battery pack should provide a useful operating life extending over several hundred charge-discharge cycles with routine care.

Each TEKTRONIX portable oscilloscope is a complete measuring system. Standard accessory items such as probes, adapters, cords, filters and a manual are included at no extra cost. Additional value is provided by a complete line of optional items: a new spectrum analyzer module compatible with these oscilloscopes, voltage probes, current probes, special adapters, cameras, protective covers and SCOPE-MOBILE® Carts.

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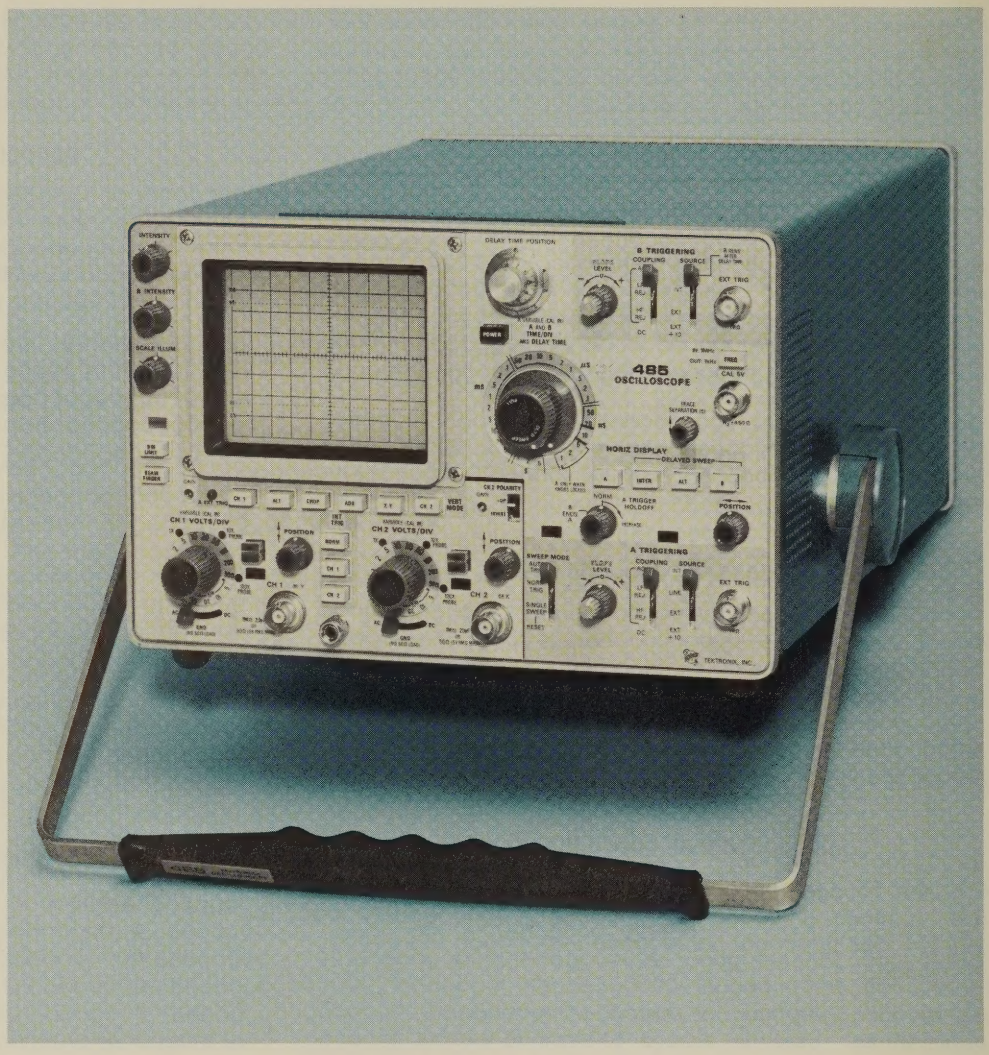
485 *350-MHz Dual-Trace Oscilloscope*

- 350 MHz at 5 mV/DIV
- 1 ns/DIV SWEEP RATE
- 6.0 DIV/ns WRITING SPEED
- ALTERNATE SWITCHING BETWEEN INTENSIFIED and DELAYED SWEEPS
- 1-MΩ and 50-Ω INPUT IMPEDANCES
- 50-Ω INTERNAL INPUT PROTECTION
- AUTOMATIC DEFLECTION FACTOR READOUT
- AUTO FOCUS
- ADJUSTABLE TRIGGER HOLDOFF
- PUSH BUTTON EXT TRIGGER DISPLAY
- 21 LB



The 485 is a 350 MHz, 1 ns/div portable dual-trace oscilloscope weighing 21 lbs, the lightest weight wide band portable oscilloscope on the market today. In addition to significantly advancing portable measurement capabilities, the 485 has many other new features. These features include selectable input impedance, adjustable trigger holdoff, EXT TRIG display, alternate delayed sweep, with trace separation control, vertical scale-factor indication, auto-focus, and B sweep intensity control. A human engineered front panel reduces measurement time. Single function push buttons and automatic vertical scale-factor indication increase operator convenience.

The 485 vertical system provides wide bandwidth at full sensitivity with selectable input impedances. At 5 mV/div sensitivity (350 MHz at 50 Ω and 250 MHz at 1 MΩ), the 485 offers more gain bandwidth than any other oscilloscope available today. Selectable input impedance provides the capability to measure low and high impedance points with the same scope and without active probes. Internal detection circuitry protects the 50-Ω input by automatically disconnecting when the signal exceeds 5 V RMS .

Automatic vertical scale-factor readout is provided by three light-emitting diodes located around the edge of each input attenuator knob. A quick glance at the readout tells the operator the correct on-screen volts/div even when the recommended 10X or 100X probes are used. The operator no longer has to remember to divide attenuation factors into dial settings each time he makes a measurement.

To complement the higher bandwidth, the 485 has a 1 ns/div sweep. A new alternate sweep mode expands the delayed sweep concept in portables. This feature allows the delayed sweep to appear alternately with the intensified main sweep. In this mode, the operator sees the intensified zone and delayed display at the same time. He always knows exactly where in a pulse train he is making a delayed sweep measurement.

The external trigger signal may be easily viewed on the 485 without disconnecting leads and resetting controls. A front panel push button automatically routes the external signal used to trigger Time Base A to the vertical deflection amplifier. This feature can also be used to quickly make time comparisons between the signal of interest and the external trigger signal.

Full bandwidth triggering (without HF sync) and "Adjustable Trigger Holdoff" provide stable presentation of repetitive complex waveforms.

An auto-focus circuit makes it unnecessary to readjust the focus each time the intensity is changed. The focus will always be correct in single shot photography. A beam current limit circuit protects the CRT phosphor from high intensity burns.

VERTICAL DEFLECTION
(2 Identical Channels)

Selectable Input Impedance—50-Ω and 1-MΩ impedance are available at a single BNC connector by push button selection.

50 Ω within 0.5%; VSWR 1.25:1 or less at 5 mV/div and 10 mV/div, 1.15:1 or less from 20 mV/div to 5 V/div to 350 MHz.

1 MΩ within 1% paralleled by approx 20 pF.

Bandwidth* and Risetime at all deflection factors from 50-Ω terminated source, −15°C to +35°C

50 Ω	DC to 350 MHz, 1 ns
1 MΩ	DC to 250 MHz, 1.4 ns

*Measured at −3 dB. Lower −3 dB point, AC coupled from 50 Ω source, is 1 kHz or less for 50 Ω and 10 Hz or less for 1 MΩ. 20 MHz bandwidth limit selection is provided.

Deflection Factor— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 2%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div. Gain can be recalibrated at the front panel.

Probe Power—Two 4-pin connectors at the rear of the instrument provide power suitable for optional active probes.

Display Modes—Channel 1; Channel 2 (Normal and Inverted); Alternate; Chopped (Approx 1-MHz rate); Added; X-Y (Channel 1-Y and Channel 2-X).

Automatic Scale Factor—Probe tip deflection factors for 10X and 100X coded probes are automatically indicated by three readout lights at the edge of the knob skirts. All lights are off when the channel is not selected for display or when the trace identification control on the probe is depressed.

50-Ω Protection—Internal detection circuitry provides protection by automatically disconnecting excessive signals of up to 50 volts. The "disconnected" condition is indicated, and has manual reset.

Maximum Input Voltage

50 Ω	Protection disconnect occurs for voltages that exceed approximately: 5 V RMS continuous. 0.1 watt-second for instantaneous voltages of 5 V to 50 V.
1 MΩ	DC Coupled— 250 V (DC + peak AC), 500 V P-P to 1 kHz
	AC Coupled— 500 V (DC + peak AC), 500 V P-P to 1 kHz

Selectable Input Coupling—AC; DC; GND (provides zero reference, precharges coupling capacitor, disconnects 50-Ω load in 50-Ω mode).

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signals), Channel 1 or Channel 2 signal.

HORIZONTAL DEFLECTION

Time Base A and B—Calibrated sweep range; 1 ns/div to 0.5 s/div in 27 calibrated steps (1-2-5 sequence). Uncalibrated A continuously variable between steps and to at least 1.25 s/div.

Time Base A and B Sweep Accuracy

Sweep Rate	+15°C to +35°C	−15°C to +55°C
1 ns/div to 20 ns/div	±3%	±5%
50 ns/div to 0.1 s/div	±2%	±4%
0.2 s/div and 0.5 s/div	±3%	±5%

A Trigger Holdoff—Adjustable control permits a stable presentation of repetitive complex waveforms. The control covers at least the time of one full sweep for sweeps faster than 0.2 s/div.

B Ends A—The A sweep is reset at the end of the B sweep to allow the fastest possible sweep repetition rate for increased trace intensity in the delayed sweep mode.

Horizontal Display Modes—A, Intensified, Alternate, and B (delayed sweep). A only is displayed for A sweep rates of 1, 2 and 5 ns/div.

Alternate Display Modes—Allows the B delayed sweep to appear alternately with the intensified A sweep. Trace separation control positions B (delayed) sweep approx 4 div from the A sweep.

CALIBRATED SWEEP DELAY

Delay Time Range—0 to 10 times Delay Time/Div setting of 10 ns/div to 0.5 s/div.

Differential Delay Time Measurement Accuracy

Delay Time Setting	+15°C to +35°C
10 ns/div and 20 ns/div	±(1% of measurement +0.2% of full scale)
50 ns/div to 1 ms/div	±(0.5% of measurement +0.1% of full scale)
2 ms/div to 0.5 s/div	±(1% of measurement +0.1% of full scale)

Full scale is 10 times the Delay Time/Div setting.

Jitter— 1 part or less in 20,000 of 10X the Time/Div setting.

TRIGGERING A and B

A Trigger Modes—Normal, sweep runs when triggered. Automatic, sweep free-runs in the absence of a triggering signal and for signals below 20 Hz. Single Sweep, sweep runs one time on the first triggering event after the reset selector is pressed.

B Trigger Modes—B Runs After Delay Time, starts automatically at the end of the delay time. B Triggerable After Delay Time, runs when triggered. The B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A & B Trigger Sensitivity

Trigger Mode		To 50 MHz	To 350 MHz
DC	Internal	0.3 div deflection	1.5 div deflection
	External	20 mV	100 mV
AC		Signals below 16 Hz are attenuated	
AC LF Reject		Signals below 16 kHz are attenuated	
AC HF Reject		Signals below 16 Hz and above 50 kHz are attenuated	

A External Trigger Display—A momentary push button selector overrides other vertical controls and displays the external signal being used for A sweep triggering. This provides quick verification of the external signal and time comparison between a vertical signal and the external trigger signal. The deflection factor is approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive and negative slope of the displayed waveform. External, level is adjustable through at least ±0.5 V for either polarity; ±5 V for EXT ÷ 10.

A Sources—Internal, line, external, external ÷ 10.

B Sources—B Runs After Delay Time, internal, external, external ÷ 10.

External Inputs— 1 MΩ paralleled by approx 20 pF. Maximum input voltage; 500 V (DC + peak AC), 500 V P-P to 1 kHz.

Jitter—0.1 ns or less at 350 MHz and 1 ns/div.

X-Y OPERATION

Full Sensitivity X-Y (CH 1-Y, CH 2-X)— 5 mV/div to 5 V/div in 10 calibrated steps (1-2-5 sequence), accurate within 2%. Y-axis bandwidth identical to Channel 1. X-axis bandwidth is DC to at least 4 MHz (−3 dB). Phase difference between amplifiers is 3° or less to 4 MHz.

CRT

TEKTRONIX CRT— 4-inch rectangular tube; 8 x 10-div display area, each div is 0.8 cm. Horizontal and vertical centerlines further marked in 0.2-div increments. P31 phosphor normally supplied; P11 optional without extra charge; 21-kV accelerating potential.

Photographic Writing Speed—At least 3 div/ns with standard P31 phosphor and at least 6.0 div/ns with optional P11 phosphor using the TEKTRONIX C-31-R Camera and Polaroid* 10,000 ASA film.

Auto Focus—Automatically maintains beam focus for all intensity settings.

Graticule—Internal, no parallax; variable edge lighting; markings for measurement of risetime. Graticule is dark with illumination off.

Beam Finder—Limits display within graticule area.

External Z-Axis—Risetime ≈15 ns. Input R ≈500 Ω. +0.2 V (DC to 20 MHz) blanks trace of average intensity. +2 V (DC to 2 MHz) blanks maximum intensity trace.

Beam Current Limit—Automatically limits the average beam current to protect the CRT phosphor.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Filtered forced air ventilation is provided. Storage: −35°C to +75°C.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Two-Frequency, Fast-Rise Calibrator—Output resistance is 450 Ω with a risetime (positive slope) into 50 Ω of 1 ns or less. 1-kHz duty cycle 49.8% to 50.2%. Amplitude is 5 V within 0.5% into 1 MΩ and 0.5 V within 1% into 50 Ω (±0.5%). Optional BNC accessory current loop provides 50 mA within 1%. Selectable repetition rates are 1 kHz and 1 MHz within 0.25%. Specifications apply over +15°C to +35°C range.

A Sweep Output—Open circuit, approximately 10 V positive-going sawtooth; into 50 Ω, approx 0.5 V.

A and B Gate Outputs—Open circuit, approximately 4 V positive-going rectangular pulse; into 50 Ω, approx 0.5 V.

Power Requirements—Recessed slide switch selects nominal operating line range. Line voltage range is 90 V to 136 V and 180 V to 272 V. 60 watts maximum power consumption at 115 V. Line frequency 48 to 440 Hz.

485 Dimensions and Weights

Height	6.6 in	16.8 cm
Width	12.0 in	30.5 cm
Depth		
handle extended	20.6 in	52.3 cm
handle not extended	18.5 in	47.0 cm
Net Weight		
with accessories	24 lb	10.9 kg
without accessories	21 lb	9.5 kg
Domestic Shipping Weight	≈31 lb	≈14 kg
Export Packed Weight	≈42 lb	≈19 kg

Included Accessories— 50-Ω 18-inch BNC cable (012-0076-00); two BNC jack posts (012-0092-00); 50-Ω terminator (011-0049-01); accessory pouch (016-0535-00). Rack models also include mounting hardware and slide out assembly (351-0101-00).

ORDERING INFORMATION

485 OSCILLOSCOPE **$4200**

R485 OSCILLOSCOPE, 7-in rack model ..... **Add $40**

485-1 OSCILLOSCOPE, without A EXT TRIG Display **$4100**

485-2 OSCILLOSCOPE, without A EXT TRIG Display and with 50-Ω input only instead of selectable input impedance **$3850**

Battery and external DC power capability to power this and other instruments is available in a stand-alone package.

OPTION 4

Electromagnetic Interference (EMI) Modification

The 485 may be ordered to meet the interference specification of MIL-I-6181D

EMI MODIFICATION, Option 4 ..... **Add $20**

OPTIONAL ACCESSORIES

Optional Accessories increase measurement capability and provide added convenience.

Current Loop Adapter—The adapter provides an accurate 50 mA squarewave calibrator when connected to the 485 voltage calibrator. The risetime is approximately 25 ns.
Order 012-0341-00 ..... $16

50-Ω 5X Pad—Provides reverse termination for the calibrator.
Order 011-0060-01 ..... $16.50

Folding Viewing Hoods—Improves viewing in high ambient light conditions.
Folds to 7/16 x 4-1/4 x 7-1/2 inches.
Order 016-0274-00 ..... $6

Folds to 9/16 x 6-3/4 x 13-3/4 inches.
Order 016-0082-00 ..... $9

SCOPE-MOBILE™ Cart—Occupies less than 18 inches aisle space, has storage area in base.
Order 200-1B $120

PROBES

Probes are not supplied with the 485. Probes should be ordered separately according to the application.

	Probe Type	Attenuation	Input Impedance	Lower −3 dB Point AC Coupled	Bandwidth with 485	Order	Price
50-Ω Input	P6056	10X	500 Ω 1 pF	200 Hz	350 MHz	010-6056-03 — 6 ft 010-6056-05 — 9 ft	$45
	P6057	100X	5000 Ω 1 pF	20 Hz	350 MHz	010-6057-03 — 6 ft 010-6057-05 — 9 ft	$45
1-MΩ Input	P6201 (FET Probe)	1X 10X } Plug-on 100X }	100 kΩ 3 pF 1 MΩ <1.5 pF 1 MΩ <1.5 pF	10 Hz 1 Hz 10 Hz	330 MHz	010-6201-01 — 6 ft	$375
	P6053A	10X	10 MΩ 9.5 pF 12 pF 13.5 pF	1 Hz	250 MHz 250 MHz 200 MHz*	010-6053-01 — 3.5 ft 010-6053-03 — 6 ft 010-6053-05 — 9 ft	$55

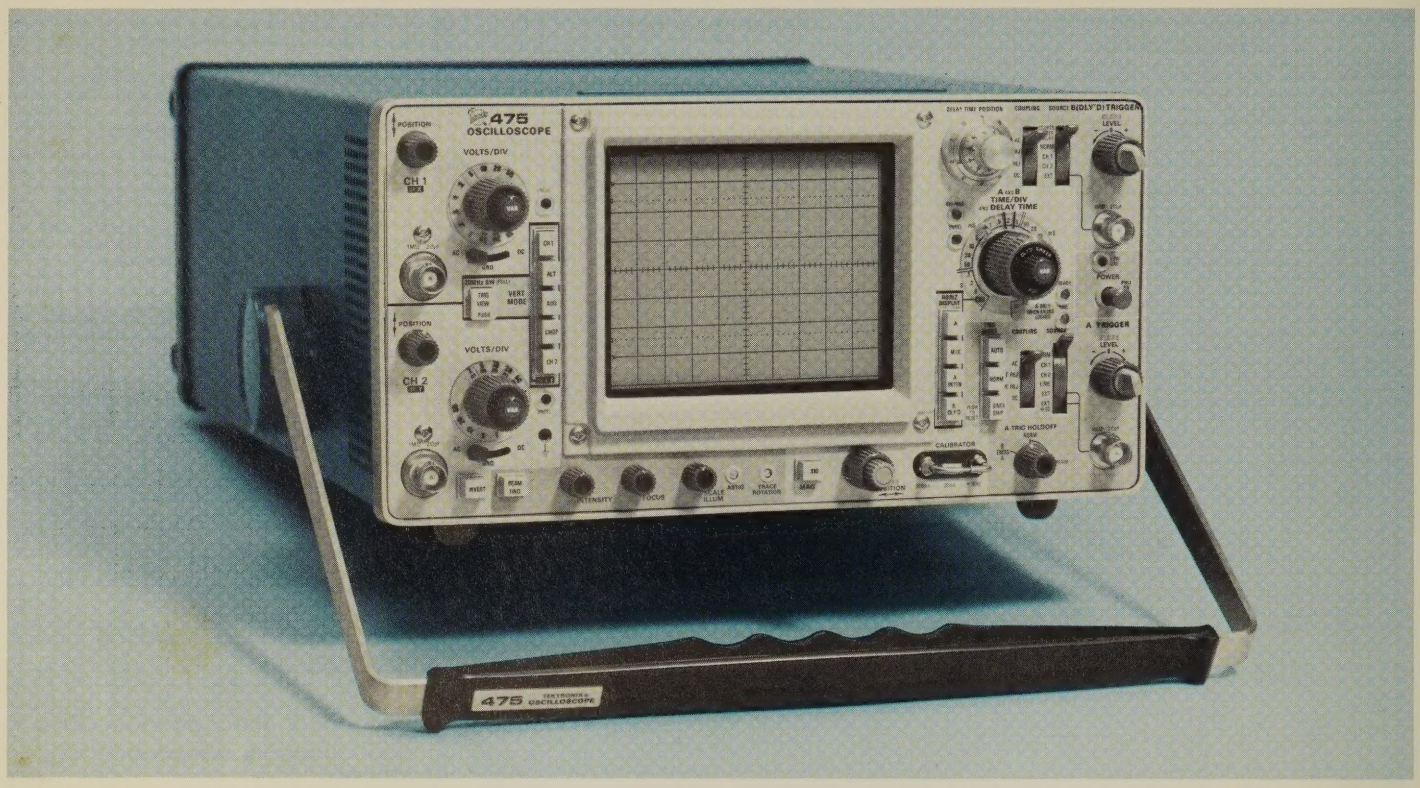
*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon

PORTABLE OSCILLOSCOPES

475 *200-MHz Dual-Trace Oscilloscope*

465 *100-MHz Dual-Trace Oscilloscope*



475 pictured above is identical in appearance to the 465 (not shown) except the 465 deletes the 0.01 and 0.02 μs TIME/DIV and 2 mV VOLTS/DIV switch positions.

- 200 MHz at 2 mV/DIV (475)
- 1 nsec/DIV SWEEP RATE (475)
- 100 MHz at 5 mV/DIV (465)
- 5 nsec/DIV SWEEP RATE (465)
- 8 x 10-cm CALIBRATED DISPLAY
- EASY-TO-OPERATE
- TRIGGER VIEW
- AUTOMATIC VOLTS/DIV READOUT
- LESS THAN 23 lb
- VERSATILE TRIGGER SELECTION
- BATTERY OPERATION
- DELAYED SWEEP

The need to view and accurately measure complex nanosecond signals on customer locations or in a "field" environment is commonplace and expected. The new 465 and 475 have been specifically designed to be easy to use and meet the high performance and portable demands of these applications.

The exceptionally low-cost of the 465 with 100 MHz at 5 mV/cm and the 475 with 200 MHz at 2 mV/cm represents a price/performance breakthrough for portables and insures top value for the future.

At less than 23 lb the new 465 and 475 portables are light, short and easy to carry (25.3 lb with panel cover and accessories). They use less travel space and are approx 20% lighter than the TEKTRONIX 453A, and 454A, the world's most widely used portables.

Although light weight, small and rugged, the 465 and 475 contain a big, bright, high-resolution CRT. Even in adverse ambient light conditions low rep-rate pulses are easily viewed. With 8 cm vertically and 10 cm horizontally the CRT display covers ⅓ of the entire front panel. Though the front panel is small in area and dominated by the larger CRT, these versatile portables are easy to use. Operation has been simplified by single-function push buttons, control knob design, layout and color-coordinated front panels.

Troubleshooting circuits and equipment is often more effectively accomplished when using external trigger sources. It is essential that the timing, amplitude and other characteristics of the external trigger waveforms are known. By simply pressing a front panel push button on the 465 or 475, any waveform applied at the A trigger input is instantly displayed, thus eliminating resetting controls and disconnecting leads. This can be a real time saver and convenience when external trigger signals are frequently being used as timing references.

In the past, multi-trace applications or measurements requiring frequent attenuation or probe changes necessitated bothersome and error-prone deflection factor determination. With the 465 and 475, probe tip deflection factors for recommended 1X and 10X probes are automatically indicated by readout lights behind the knob skirts.

Measuring with respect to ground is important in many applications. This is easily accomplished at the probe when DC coupled by simply pressing the small ground reference push button on the probes recommended for 465 and 475 use.

The 465 and 475 can be operated from either a free-standing battery pack or one which attaches directly to the oscilloscope. Both are small and light weight, providing a handy solution for making accurate measurements in difficult environments such as conducted EMI, ground loops, power line fluctuations, or in the absence of line power.

CHARACTERISTICS

All characteristics apply to both the 465 and 475 except where indicated.

VERTICAL DEFLECTION
(2 Identical Channels)

Bandwidth* and Risetime at all deflection factors from 50 Ω terminated source, 0°C to +40°C

465—DC to at least 100 MHz, 3.5 ns or less. 50 MHz cascaded at approx 1 mV/div.

475—DC to at least 200 MHz, 1.75 ns or less. 50 MHz cascaded at approx 400 μV/div.

*Measured at —3 dB down. Bandwidth may be limited to approximately 20 MHz by bandwidth limit switch.

Lower —3 dB point, AC coupling from 50-Ω source

465/475	X1 Probe	10 Hz or less
	X10 Probe	1 Hz or less

Deflection Factor

465— 5 mV/div to 5 V/div in 10 calibrated steps**

475— 2 mV/div to 5 V/div in 11 calibrated steps**

**1, 2, 5 sequence, accurate within 3%. Uncalibrated, continuously variable between steps and to at least 12.5 V/div.

Display Modes—Channel 1; Channel 2 (normal and inverted); Alternate; Chopped (465—approx 250-kHz rate, 475—approx 1-MHz rate); Added; X-Y (selected by Time/div, CH 1-X, CH 2-Y)

Automatic Scale Factor Readout—Probe tip deflection factors for 1X or 10X coded probes are automatically indicated by two readout lights behind the knob skirts. All lights are off when the channel is not displayed. Ground reference display selectable at probe (when DC coupled).

Input R and C— 1 megohm within 2% paralleled by approx 20 pF.

Maximum Input Voltage

DC Coupled	250 V (DC + Peak AC)
	500 V P-P AC at 1 MHz or less
AC Coupled	500 V (DC + Peak AC)
	500 V P-P AC at 1 kHz or less

Signal Output—CH 1 vertical signal is DC to at least 50 MHz —3 dB and approx 25 mV/div when terminated in 50 Ω, and approx 50 mV/div terminated into 1 megohm.

Delay Line—Permits viewing leading edge of displayed waveform.

Probe Power (for 475 only)—Connectors provide correct voltages for two optional P6201 FET Probes.

HORIZONTAL DEFLECTION

465

Time Base A— 0.05 μs/div to 0.5 s/div in 22 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 5 ns/div.

Time Base B— 0.05 μs/div to 50 ms/div in 19 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 5 ns/div.

475

Time Base A and B— 0.01 μs/div to 0.5 s/div in 24 calibrated steps (1-2-5 sequence). X10 MAG extends maximum sweep rate to 1 ns/div.

Variable Time Control; Time Base A (465/475)—Provides continuously variable uncalibrated sweep rates between steps and to at least 1.25 s/div. Warning light indicates uncalibrated setting.

Time Base A and B Accuracy (465/475)

	+20°C to +30°C	—15°C to +55°C
Unmagnified	±2%	±3%
Magnified	±3%	±4%

Horizontal Display Modes—A only, Mixed Sweep, A Intensified, B Delayed.

Time Base A Sweep Modes—Auto Trigger (sweep free runs in absence of triggering signal), Normal Trigger, Single Sweep. Lights indicate when sweep is triggered and when single sweep is ready.

Time Base B Sweep Modes—B Starts After Delay Time; B Triggerable after Delay Time from selected source.

Calibrated Mixed Sweep—Displays A sweep for period determined by DELAY-TIME POSITION control, then displays B sweep for remainder of horizontal sweep. Mixed sweep measurements utilize portions of the A and B sweeps. Accurate to within 2% plus measured A sweep accuracy for the A portion of the display and to within the B accuracy for the B portion of the display.

CALIBRATED SWEEP DELAY

Delay Time Range

465— 0.2 to 10X Delay Time/Div settings of 200 ns to 0.5 s (minimum delay time is 200 ns).

475— 0 to 10X Delay Time/Div settings of 50 ns to 0.5 s (minimum delay time is 50 ns).

Differential Time Measurement Accuracy

Delay Time Setting	+15° to +35°C
over one or more major dial divisions	within 1%
less than one major dial division	within 0.01 major dial divisions

Jitter— 1 part or less in 50,000 (0.002%) 10X of the A sweep time/div setting. 1 part in 20,000 when operating from 50 Hz line.

TRIGGERING A and B

A Trigger Modes—Normal (sweep runs when triggered), Automatic (sweep free-runs in the absence of a triggering signal and for signals below 30 Hz), Single Sweep (sweep runs one time on the first triggering event after the reset selector is pressed).

B Trigger Modes—B Runs After Delay Time (starts automatically at the end of the delay time), B Triggerable After Delay Time (runs when triggered), the B (delayed) sweep runs once, in each of these modes, following the A sweep delay time.

Time Base A and B Trigger Sensitivity

Trigger Mode		465 To 25 MHz	465 At 100 MHz	475 To 40 MHz	475 At 200 MHz
DC	Internal	0.3 cm deflection	1.5 cm deflection	0.3 cm deflection	1.5 cm deflection
	External	50 mV	150 mV	50 mV	250 mV
	External ÷ 10	500 mV	1.5 V	500 mV	2.5 V
AC		Requirements increase below 60 Hz			
AC LF Reject		Requirements increase below 50 kHz			
AC HF Reject		Requirements increase below 60 Hz and above 50 kHz			

465 Jitter— 0.5 ns or less at 100 MHz and 5 ns/div. (X10 Mag on)

475 Jitter— 0.2 ns or less at 200 MHz and 1 ns/div. (X10 Mag on)

A Trigger View—A momentary push button selector overrides other vertical controls and displays the signal being used for A sweep triggering. This provides quick verification of the signal and time comparison between a vertical signal and the trigger signal. The deflection factor is approximately 50 mV/div (0.5 V/div with Ext ÷ 10 source).

Level and Slope—Internal, permits selection of triggering at any point on the positive or negative slope of the displayed waveform.

Time Base Trigger Sources—A: Norm, Channel 1, Channel 2, Line, External and External ÷ 10. B: Starts After Delay, Norm, CH 1, CH 2, and External. Level adjustment through at least ±2 Volts in External, through at least ±20 Volts in External ÷ 10.

External Inputs—R and C approx 1 MΩ paralleled by approx 20 pF. 250 V (DC + peak AC) maximum input.

X-Y OPERATION

465

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)— 5 mV/div to 5 V/div in 10 calibrated steps, accurate within 4%. Bandwidth is DC to at least 4 MHz. Phase difference between amplifiers is 3° or less from DC to 50 kHz.

475

Full-sensitivity X-Y (CH 1 Horiz, CH 2 Vert)—2 mV/div to 5 V/div in 11 calibrated steps, accurate within 3%. Bandwidth is DC to at least 1 MHz. Phase difference between amplifiers is 1° or less from DC to 1 MHz.

CRT

TEKTRONIX CRT— 5 inch rectangular tube; 8 x 10 cm display area. Horizontal and vertical centerlines further marked in 0.2-cm increments. P31 phosphor normally supplied; P11 optional without extra charge. 18-kV accelerating potential.

Z-axis input—DC-coupled to CRT cathode; noticeable modulation at normal intensity with 5 V or more peak-to-peak signal; DC to 50 MHz usable frequency range.

Graticule—Internal, nonparallax; variable edge lighting; markings for measurement of risetime.

Beam Finder—Compresses trace to within graticule area for ease in determining the location or relative magnitude of an off-screen signal regardless of settings of vertical and horizontal position controls. A preset intensity level provides a constant brightness.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: —15°C to +55°C. Storage: —55°C to +75°C. Filtered forced air ventilation is provided.

Altitude—Operating: to 15,000 feet; maximum allowable ambient temperature decreased by 1°C/1000 feet from 5,000 to 15,000 feet. Nonoperating to 50,000 feet.

Vibration—Operating: 15 minutes along each of the three axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference (OPTION 4 only)—Meets interference requirements of MIL-I-6181D, power line conducted, 150 kHz to 25 MHz. Radiated (with included mesh filter installed), 150 kHz to 1 GHz.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-F-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Amplitude Calibrator

Output Voltage	0.3 Volts	1% 0°C to +40°C
Output Current	30 mA	2% +20° to +30°C
Frequency	Approx 1 kHz	

Signal Outputs—Positive gates from both time bases (approx 5 V), and a vertical signal output from one channel.

Power Requirements—Quick-change line voltage selector provides six ranges: 110 V, 115 V, 120 V, 220 V, 230 V and 240 V, each ±10%. 48 to 440 Hz, 75 watts (465) or 100 watts (475) maximum at 115 V and 60 Hz. Battery and external DC power capability to power the 465 and 475 is available.

Dimensions and Weights

Height	6.2 in	15.7 cm
Width (with handle)	12.9 in	32.8 cm
Depth (with panel cover)	18.1 in	46.0 cm
Depth (handle extended)	20.3 in	51.6 cm
Net Weight (w/o panel cover)	22.8 lb	10.3 kg
Net Weight (with panel cover and accessories)	25.3 lb	11.5 kg
Domestic Shipping Weight	≈32.7 lb	≈14.8 kg
Export Packed Weight	≈48.0 lb	≈21.8 kg

465

Included Accessories—Two 6 ft P6075 Probes with accessories (010-6065-03); accessory pouch (016-0535-02); blue CRT light filter (337-1674-00); clear CRT light filter (337-1674-01).

475

Included Accessories—Two 6 ft. P6075 Probes with accessories (010-6075-03); accessory pouch (016-0535-02); blue CRT light filter (337-1674-00); clear CRT light filter (337-1674-01).

ORDERING INFORMATION

465 OSCILLOSCOPE $1725
475 OSCILLOSCOPE $2500
R465 OSCILLOSCOPE $1800
R475 OSCILLOSCOPE $2575

EMI ENVIRONMENTALIZED, OPTION 4

465 OPTION 4 OSCILLOSCOPE ..... Add $75
475 OPTION 4 OSCILLOSCOPE ..... Add $75

TV SYNC SEPARATOR, OPTION 5 (465 ONLY)

465 OPTION 5 OSCILLOSCOPE ..... Add $100

EXTERNAL DC OPERATION, OPTION 7

465 OPTION 7 OSCILLOSCOPE ..... Add $75
475 OPTION 7 OSCILLOSCOPE ..... Add $75

OPTIONAL ACCESSORIES

Probes

P6201 1X FET Probe Package (for 475 only), order 010-6201-01 ..... $375

P6048 10X Probe Package, order 010-0215-00 ..... $65

C-30A Compact Camera—f/1.9 lens, magnification variable from 1.5 to 0.7, Polaroid Land* Pack-Film back for 3000-speed film, order C-30A-P $525

Camera Adaptor—Adapts C-30A to 465 or 475, order 016-0301-00 ..... $35

Folding Polarized Viewing Hood—order 016-0180-00 ..... $ 9

Mesh Filter—Improves contrast and EMI filtering, order 378-0726-01 ..... $15

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base, order 200-1B $120

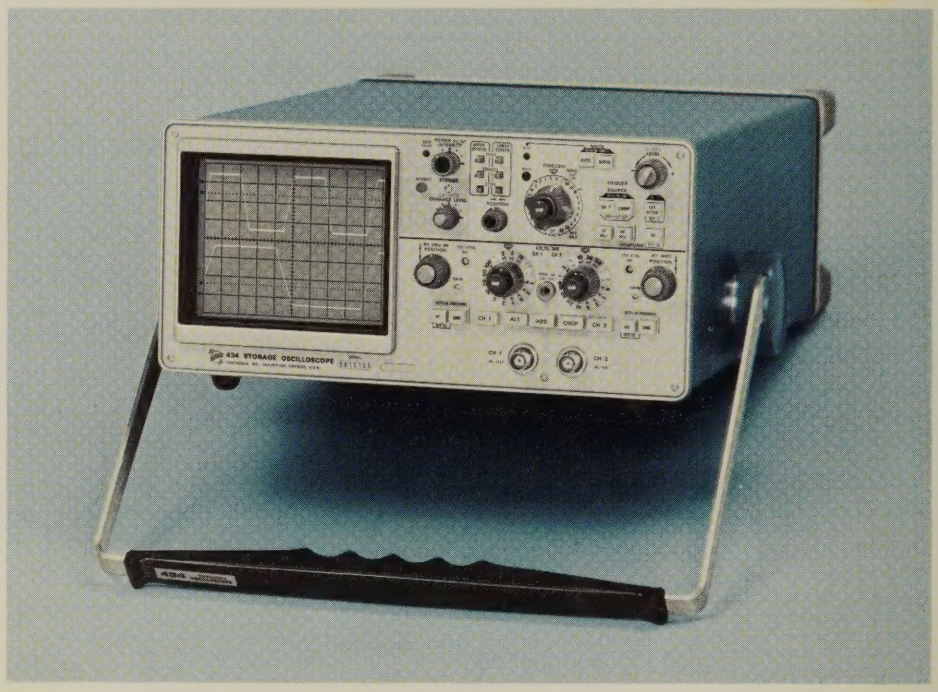
*Registered Trademark Polaroid Corporation

U.S. Sales Prices FOB Beaverton, Oregon

PORTABLE OSCILLOSCOPES

432 *25-MHz Dual-Trace Oscilloscope*

434 *25-MHz Dual-Trace Bistable Storage Oscilloscope*



- DEFLECTION FACTORS to 1 mV/DIV
- LIGHTED KNOB SKIRTS for VOLTS/DIV READOUT, AUTOMATICALLY CORRECTS for 10X PROBES
- DIRECT-READING WIDE-RANGE MAGNIFIER
- 20¾ LB
- 5¼-INCH RACKMOUNT

The 432 and 434 have identical performance characteristics, except the 434 has a bistable storage CRT. These dual-trace oscilloscopes with bandwidth to 25 MHz, sweep rates to 20 ns/div and deflection factors to 1 mV/div cover a wide range of laboratory and field applications. Both instruments are small and light. Cabinet height is 5¾ inches including the feet, (rackmount height is 5¼ inches) and weight is 20¾ pounds. Applications include field maintenance areas where conventional AND storage capability are needed. Laboratory and engineering applications areas include electrical, mechanical and civil engineering, medicine, education, acoustics, biology, chemistry, forestry, oceanography and many others. Small size makes it easy to take these instruments to the field as well as carry them from one laboratory to another.

The retention feature of the 434 storage CRT is useful for displaying many kinds of signals, especially single and low repetition rate events. Signals with repetition rates low enough to cause flicker are usually very distracting. Storage displays these signals at a constant light level. With storage, the operator can obtain displays of aperiodic or random events quickly and easily. Once the signal of interest is located and stored, the display can be photographed for high quality, permanent records.

The 434 displays stored events in a view mode for as long as four hours at constant intensity and resolution. This permits the operator to view the event as it's displayed, and study it as long as necessary at his convenience. When interruptions occur he's free to leave the stored display for extended periods without being concerned that the trace might degrade or lose resolution.

Split-screen storage operates in each of three modes: full-screen storage, or upper (or lower) screen storage with the other half in a conventional mode. Events stored on the upper (or lower) area are stable reference points for events displayed in a conventional mode on the other half of the CRT.

The split-screen storage CRT provides the convenience of storage and conventional displays on the same CRT at the same time. This capability is useful in many applications. For instance, the operator may wish to store a reference trace and then view the change in waveform characteristics as he varies circuit components. He does this easily by operating half of the display in a stored mode and the other half in a conventional mode. Thus, amplitude, duration, and other characteristics of waveforms displayed in a conventional mode can be adjusted precisely to the stored reference trace.

Comparison of changing phenomena is easily made using the TEKTRONIX unique split-screen storage CRT. In measurement of pulse response as a function of temperature, for example, a reference display can be stored on the upper screen area, then compared with subsequent displays stored on the lower screen area. The effect of the temperature change is easily seen. After studying the pulse changes, the user can erase either half of the screen and store a third display under still different conditions. This procedure can be repeated as often as needed. The operator presses one button to erase the upper half of the CRT and a second button to erase the lower half. Pressing both buttons simultaneously erases the full screen.

The writing speed of the bistable storage CRT is variable from 100 div/ms to 400 div/ms on the 434. Option 1 increases the normal writing speed to 500 div/ms and to 5000 div/ms in enhanced operation. This allows the user to choose the writing rate best suited for his requirements.

The design of the TEKTRONIX storage CRT makes it highly resistant to burns. It requires only the same operating care as a conventional CRT.

Vertical scale-factor readout is provided by lighted knob skirts which automatically indicate the correct reading, even when using the recommended 10X probes. This feature saves time and reduces errors by freeing the user from having to calculate the scale factor each time a measurement is made with the 10X probes.

434 STORAGE

TEKTRONIX Storage CRT— 5-inch rectangular tube, 8 x 10 div (1 div = 0.98 cm) display area. Phosphor is similar to P1. 4-kV accelerating potential.

Graticule—Internal, parallax-free, nonilluminated.

Split-Screen Storage— 3 Display Modes: Storage on either upper or lower half of screen with conventional display on other half. Storage on entire screen or conventional display on entire screen. Independent operation of both halves.

Writing Speed (Center 8 div)—Normal, 100 div/ms. Enhanced, increases single-sweep storage writing speed to at least 400 div/ms. (Option 1, 500 div/ms, normal; to 5000 div/ms, enhanced).

Storage Viewing Time—Up to four hours.

Erase Time— 300 ms or less.

CHARACTERISTICS

The following characteristics apply to both the 432 Oscilloscope and 434 Storage Oscilloscope, except where noted:

VERTICAL DEFLECTION
(2 Identical Channels)

Deflection Factor— 1 mV/div to 10 V/div in 13 calibrated steps (1-2-5 sequence), accurate within 3%. Lighted knob skirts indicate correct deflection factor for either 1X or 10X probes. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Bandwidth and Risetime—(from 50-Ω terminated source, with or without 10X probe) DC to at least 25 MHz at 3-dB down*, 14 ns from 10 mV/div to 10 V/div, decreasing to 15 MHz, 22 ns at 1 mV/div. Low-frequency 3-dB down point with AC coupling is 14 Hz or less (less than 1 Hz with 10X probe).

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approximately 100 kHz); Added.

Input R and C— 1 megohm ±2% paralleled by approx 24 pF.

Maximum Input Voltage—DC coupled: 250 V (DC plus peak AC), AC coupled: 500 V (DC plus peak AC). In either mode the maximum AC is 500 V P-P at 1 kHz or less.

Delay Line—Permits viewing of leading edge of triggering waveform.

Internal Trigger Source—Composite (displayed signals) or Channel 1 signal only.

HORIZONTAL DEFLECTION

Time Base— 0.2 μs/div to 5 s/div in 23 calibrated steps (1-2-5 sequence). Uncalibrated, continuously variable between steps and to 12.5 s/div. Accurate within 3% unmagnified and 4% magnified from +20°C to +30°C, within 4% unmagnified and 5% magnified from −15°C to +55°C.

Direct Reading Magnifier—Six-position, push-to-turn, 50X maximum. Extends fastest sweep rate to 20 ns/div.

Time Base Sweep Modes—Auto Trigger, (sweep free runs in absence of triggering signal and provides bright baseline at all sweep rates), Normal Trigger, Single Sweep.

External Horizontal Input—Deflection factor is approx 0.5 V/div. Input resistance is approx 50 kΩ.

TRIGGER

COUPLING		TO 5 MHz	AT 25 MHz
DC	INTERNAL	0.3 div deflection	1 div deflection
	EXTERNAL	50 mV	175 mV
AC		Same as DC at 20 Hz and above, requirements increase below 20 Hz	
AC LF REJECT		Same as AC at 50 kHz and above, requirements increase below 50 kHz	
AC HF REJECT		Same as AC at 50 kHz and below, requirements increase above 50 kHz	

Sources—Channel 1 only, composite, line, external and external ÷ 10. Input R approximately 1 megohm. Maximum external input, 250 Volts (DC + peak AC). External trigger level range is at least +2 V to −2 V or +20 V to −20 V.

432 CRT

TEKTRONIX CRT— 5-inch rectangular tube, 8 x 10 cm display area. P31 phosphor normally supplied. P7 is optional without extra charge. 4-kV accelerating potential.

Graticule—Internal, parallax-free, nonilluminated.

ENVIRONMENTAL CAPABILITIES
(Oscilloscope and Probe)

Ambient Temperature—Operating, −15°C to +55°C. Storage, −55°C to +75°C.

Altitude—Operating, 15,000 feet. Maximum allowable operating temperature decreases 1°C/1000 feet from 5,000 to 15,000 feet.

Vibration—Operating and non-operating, 15 minutes along each of the three major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute sweeps.

Shock—Operating and non-operating, 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Electromagnetic Interference—With the optional mesh filter (378-0682-00) installed the 432 and 434 meet interference requirements of MIL-I-6181D. Conducted, 150 kHz to 25 MHz. Radiated, 150 kHz to 1 GHz.

Humidity—Operating and storage, 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F (par 4.5.9 through 4.5.9.5.1, class 4).

OTHER CHARACTERISTICS

Locate—When the 434 is operated in the stored mode, the beam can be positioned to the left of the graticule area to determine the vertical position of the next sweep without disturbing a stored display.

Beam Finder—Compresses display to within graticule area independent of position controls or input signal amplitude, for ease in determining the location of an off-screen signal.

Z Axis—Input DC coupled to CRT, noticeable modulation at normal intensity with 5 volts or more P-P, DC to at least 20 MHz.

Amplitude and Time Calibrator—0.6 V adjustable within 1.0%. Repetition rate is adjustable to 1 kHz within 1.0% (+20°C to +30°C). Output resistance is 575 ohms.

Power Requirements—Operates without range switching on all voltages from 100 V to 240 V, 50 to 400 Hz, 90 VA (55 w) max (432), 120 VA (75 w) max (434). Also operates from 105 VDC to 250 VDC.

	Cabinet		Rackmount	
Dimensions	**in**	**cm**	**in**	**cm**
Height	5.6	14.2	5.3	13.3
Width with handle	13.0	33.0	19.0	48.3
Depth	18.7	47.5	18.0	45.7
Weight (approx)	**lb**	**kg**	**lb**	**kg**
Net weight	20.8	9.4	23.1	10.5
Domestic shipping	30.0	13.6	42.6	19.4
Export-packed	35.0	15.9	62.6	28.4

Included Accessories—Two P6061 3.5-ft probes with accessories (010-6061-01); accessory pouch (016-0165-00).

ORDERING INFORMATION

432 OSCILLOSCOPE	$1585
434 STORAGE OSCILLOSCOPE	$2150
434 STORAGE OSCILLOSCOPE (Option 1)	$2175
R432 OSCILLOSCOPE (Rackmount model)	$1625
R434 STORAGE OSCILLOSCOPE (Rackmount model)	$2190
R434 STORAGE OSCILLOSCOPE (Rackmount model, Option 1)	$2215

OPTIONAL ACCESSORIES

Optional accessories increase measurement capability and provide added convenience. The standard probes supplied with these oscilloscopes satisfy most measurement requirements; optional probes, including high voltage and current probes, may be better suited for particular applications. See the accessory pages of this TEKTRONIX catalog.

Mesh Filter—Improves contrast and EMI filtering.
Order 378-0682-00 ..... $15

Portable to Rackmount Assembly—Includes hardware for converting standard 432 and 434 to 19-inch rack installation.
Order 016-0272-00 ..... $60

Folding Polarized Viewing Hood—Order 016-0180-00 ..... $9

Clear Plastic CRT Filter—Order 378-0677-00 ..... $.90

Camera Adapter—Mounts C-30A Series Camera to the 432 & 434 Oscilloscope. Order 016-0301-00 ..... $35

SCOPE-MOBILE® Cart—Occupies less than 18 inches aisle space, has storage area in base. Order 200-1B $120

*Bandwidth derating to 22 MHz at temperatures above +30°C.

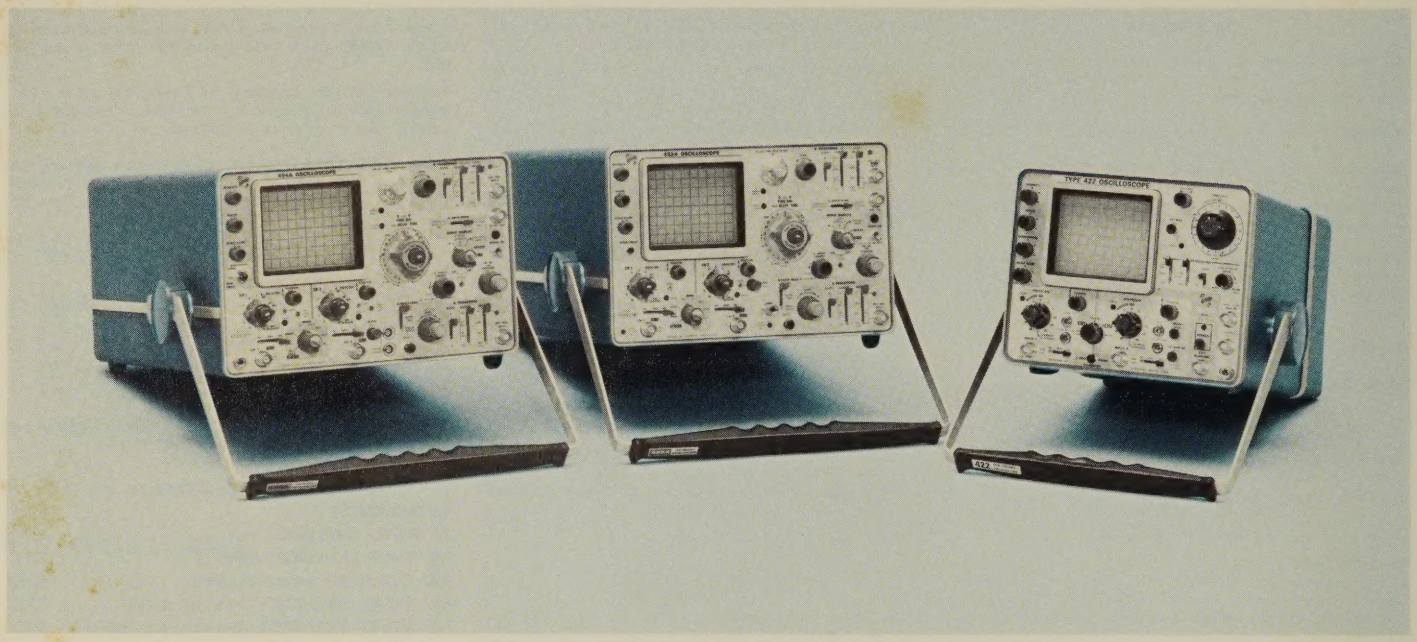
U.S. Sales Prices FOB Beaverton, Oregon

PORTABLE OSCILLOSCOPES

454A 150-MHz Dual-Trace Oscilloscope

453A 60-MHz Dual-Trace Oscillocope

422 15-MHz Dual-Trace Oscilloscope



454A

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

Bandwidth and Risetime—DC to 150 MHz (2.4 ns) from 10 mV/div to 5 V/div, DC to 100 MHz (3.5 ns) at 5 mV/div, DC to 50 MHz (7.0 ns) at 2 mV/div.

Calibrated Deflection Factor— 10 mV/div to 5 V/div at full bandwidth, 2 mV/div and 5 mV/div at reduced bandwidth.

Input R and C— 1 megohm paralleled by approx 15 pF.

HORIZONTAL

Calibrated Time Base— 20 ns/div to 5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 2 ns/div.

Delay Range— 10 ns to 50 s.

Calibrated X-Y Operation— 2 mV/div to 5 V/div in 11 steps, DC to 2 MHz.

CRT

Display Area— 8 x 10 division (0.8 cm/div)

Accelerating Voltage— 14 kV

Phosphor— P31

OTHER

Amplitude and Time Calibrator— 1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 62 Hz, 116 W at 115 VAC.

453A and 454A Dimensions and Weights

Height	7.1 in	18.1 cm
Width (with handle)	12.5 in	31.8 cm
Depth (incl. panel cover)	20.5 in	52.1 cm
Depth (handle extended)	22.4 in	56.8 cm
Net weight (w/o panel cover)	29.3 in	13.3 cm
Net weight (with panel cover and accessories)	31.3 in	14.2 cm
Domestic shipping weight	≈43 lb	≈19.5 kg
Export-packed weight	≈57 lb	≈25.9 kg

R453A and R454A Dimensions and Weights

Height	7.0 in	17.8 cm
Width	19.0 in	48.3 cm
Depth (behind front panel)	18.0 in	45.7 cm
Net weight	33.5 in	15.2 cm
Domestic shipping weight	≈65 lb	≈29.5 kg
Export-packed weight	≈86 lb	≈39.0 kg

Included Accessories—Two P6054 Probes with accessories (010-6054-01); 50-Ω 18-inch BNC cable (012-0076-00); BNC jack post (012-0092-00); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

Order 454A OSCILLOSCOPE **$3200**
Order R454A OSCILLOSCOPE (Rackmount model) **$3285**
Order 454A MOD 431Y (for 400 Hz operation) **$3300**

453A-Series

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

Bandwidth and Risetime—DC to 60 MHz (5.8 ns) from 20 mV/div to 10 V/div, DC to 50 MHz (7 ns) at 10 mV/div, DC to 40 MHz (8.75 ns) at 5 mV/div.

Calibrated Deflection Factor— 20 mV/div to 10 V/div at full bandwidth, 5 mV/div and 10 mV/div at reduced bandwidth.

Input R and C— 1 megohm paralleled by approx 20 pF.

HORIZONTAL

Calibrated Time Base— 0.1 μs/div to 5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 10 ns/div.

Calibrated X-Y Operation— 5 mV/div to 10 V/div in 11 steps.

Delay Range— 0.2 μs to 50 s.

External Input— 270 mV/div or 2.7 V/div dual trace, 5 mV/div to 10 V/div single trace.

CRT

Display Area— 8 x 10 divisions (0.8 cm/div)

Accelerating Voltage— 14 kV.

Phosphor—P31

OTHER

Amplitude and Time Calibrator— 1 V or 0.1 V output, 5 mA output, 1-kHz squarewave.

Power Requirements— 90 to 136 V or 180 to 272 V, 48 to 62 Hz, 92 W at 115 VAC.

Dimensions and Weights—Same as 454A.

Included Accessories—Two P6061 Probes with accessories (010-6061-01); 50-Ω 18-inch BNC cable (012-0076-00 ; BNC jack post (012-0092-00); blue light filter (378-0664-00) and CRT ornamental ring (354-0248-00), both installed. Rack models also include mounting hardware, slide-out assembly (351-0101-00).

Included Accessories with 453A-1, 2, 3, or 4—Includes two P6061 Probes with accessories (010-6061-01).

ORDERING INFORMATION

453A OSCILLOSCOPE* **$2050**
R453A OSCILLOSCOPE* (Rack Model) **$2135**
453A-1 OSCILLOSCOPE **$1850**
453A-2 OSCILLOSCOPE **$1875**
453A-3 OSCILLOSCOPE **$1900**
453A-4 OSCILLOSCOPE **$1700**
*with normal, calibrated delayed sweep, calibrated mixed sweep and 5 mV X-Y.

422

CHARACTERISTIC SUMMARY

VERTICAL
(2 Identical Channels)

Bandwidth and Risetime—DC to 15 MHz (24 ns) at 3-dB down (each channel).

Calibrated Deflection Factor—10 mV/div to 20 V/div in 11 calibrated steps.

Input R and C—1 MΩ paralleled by approx 33 pF.

HORIZONTAL

Calibrated Time Base—0.5 μs/div to 0.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest rate to 50 ns/div.

CRT

Display Area— 8 x 10 divisions (0.8 cm/div).

Accelerating Voltage— 6 kV.

Phosphor—P31 with P2, P7, P11 optional.

OTHER

Amplitude and Time Calibrator— 0.2 V and 2 V at 1 kHz, squarewave.

Power Requirements— 90 to 136 VAC or 180 to 272 VAC, 50 to 400 Hz, 34 watts at 115 VAC.

Dimensions and Weights (422)

Height	6.9 in	17.7 cm
Width with handle	9.4 in	23.8 cm
Depth, handle not extended	15.8 in	40.0 cm
Depth, handle extended	17.8 in	45.3 cm
Weight with accessories	21.3 lb	9.7 kg
Domestic shipping weight	≈30.0 lb	≈13.6 kg
Export-packed weight	≈44 lb	≈20.0 kg

ORDERING INFORMATION

422 AC POWERED PORTABLE

Inncluded Accessories—Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00); both installed; clear, CRT protector plate (366-0118-00); AC power supply (016-0072-00); power cord, 117 V, 3-conductor right-angle, female with straight male plug (161-0024-03).

422 OSCILLOSCOPE **$1600**

422 AC/DC POWERED PORTABLE

Included Accessories—Two P6012 10X probes (010-0203-00); blue light filter (378-0558-00) and CRT ornamental ring (354-0248-00), both installed; clear, CRT protector plate (386-0118-00); AC/DC power supply (016-0073-00); 3-wire AC with female connector and male plug power cord (161-0015-01); 3-wire DC with female connector power cord (161-0016-01).

422 MOD 125B Oscilloscope, without Battery Pack **$1770**

Battery Pack for 422 MOD 125B
Order 016-0066-02 ..... $100

U.S. Sales Prices FOB Beaverton, Oregon

- 1 mV/DIV to 10 V/DIV CALIBRATED DEFLECTION FACTORS
- AC, DC or BATTERY POWERED
- COMPACT SIZE—WEIGHT <13 LB
- 5-MHz BANDWIDTH at 1 mV/DIV
- DESIGNED for SEVERE ENVIRONMENTS
- CONVENIENT ACCESSORY STORAGE

The 326 is an all solid-state, dual channel, 10-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 326 features small size and light weight, together with low power consumption. Depth is 15 inches, width is 8.7 inches, height is 4.0 inches, and weight is less than 13 pounds. Power consumption is only 12 watts from an external DC source and 35 watts when powered from the AC line. Internal rechargeable batteries will provide up to 4 hours continuous operation. The portability/performance provided by the 326 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 10 MHz at 3-dB down. DC to at least 5 MHz at 3-dB down using X10 gain. Low-frequency 3-dB-down point with AC coupling is 10 Hz or less, extending to 1 Hz or less with the included 10X probe.

Risetime—36 ns or less; 72 ns or less using X10 gain.

Deflection Factor—10 mV/div to 10 V/div in 10 calibrated steps (1-2-5 sequence), 1 mV/div to 1 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 25 V/div.

Display Modes—Channel 1 only; Channel 2 only (normal or inverted); Alternate; Chopped (approx 110-kHz rate); Added.

Input R and C—1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage—500 V (DC + peak AC).

Delay Line—Permits viewing leading edge of displayed waveform.

Internal Trigger Source—Normal (displayed signal) or Channel 1 signal only.

HORIZONTAL DEFLECTION

Time Base—1 μs/div to 1 s/div in 19 calibrated steps (1-2-5 sequence); accurate within 3% over the center 8 divisions from 1 μs/div to 0.2 s/div; accurate within 4% at 0.5 s/div and 1 s/div. Uncalibrated, continuously variable between steps and to approx 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.1 μs/div. Accuracy of magnified display is within 4% over the center 8 divisions from 0.5 μs/div to 20 ms/div, within 5% at 0.1 μs/ div, 0.2 μs/div, 50 ms/div and 0.1 s/div.

External Input—Continuously variable from approx 25 mV/div to approx 1.5 V/div. AC or DC coupled. DC to at least 200 kHz at 3-dB down.

Input and output connections are provided on the left side panel, freeing important front panel space for operating controls.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC)

Amplitude Requirements—0.3-div deflection or 150 mV external to 1 MHz, increasing to 1.0-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 50 kHz with AC LF REJ coupling.

CRT

CRT—8 x 10-div display area; each div is ¼ inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your field engineer, representative or distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 50 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, nonilluminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Nonoperating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum; maximum ambient temperature must be decreased by 1°C/1000 feet from 5,000 feet to 15,000 feet. Nonoperating: 50,000 feet.

Vibration—Operating. 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Nonoperating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator—0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probes—The P6049A is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 9 size "C" NiCd cells providing 1.5 to 4 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Charger provides for charging the internal batteries when connected to the AC line, operating or nonoperating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of 7.2 V to 32 V, requires up to 12 W.

External AC source: Operates from an external AC source of 90 V to 136 V or 180 V to 272 V. 48 to 440 Hz, 35 W maximum at 115 VAC.

Dimensions and Weights		
Height	4.0 in	10.2 cm
Width with handle	8.7 in	22.2 cm
Depth, handle not extended		
With charger	15.0 in	38.1 cm
Without charger	12.2 in	31.0 cm
Depth, handle extended		
With charger	18.2 in	46.2 cm
Without charger	15.8 in	40.1 cm
Net weight without accessories		
With charger	≈13 lb	≈5.9 kg
Without charger	≈10 lb	≈4.5 kg
Domestic shipping weight	≈21 lb	≈9.5 kg
Export-packed weight	≈29 lb	≈13.1 kg

Included Accessories—Two P6049A 10X probes (010-6049-01); carrying case (016-0532-00); strap asembly (346-0098-00); viewing hood (016-0297-00); blue light filter (426-0871-00); external DC cable assembly (012-0406-00).

Order 326 OSCILLOSCOPE, including power pack . . . $1650

The SONY®/TEKTRONIX® 326 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 326 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

OPTIONAL ACCESSORIES

Battery Set—Set of 9 NiCd cells, order 146-0018-00 ..... $40

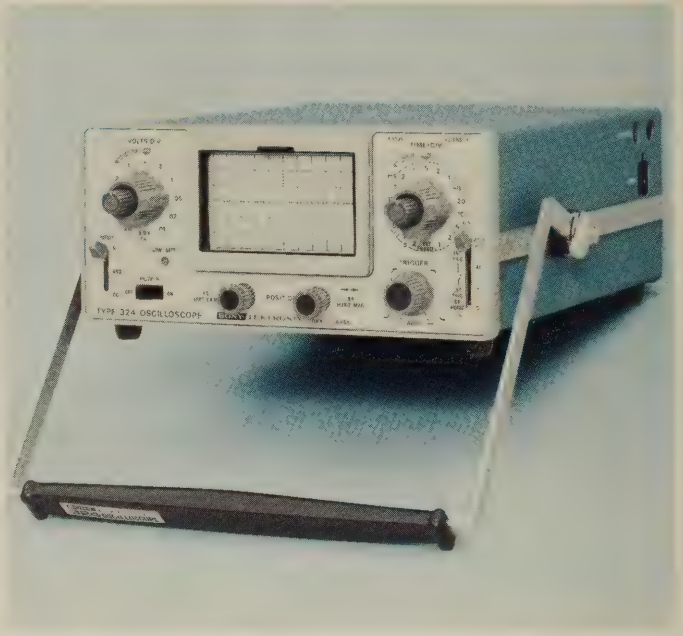
Battery Pack—Includes 146-0018-00 in battery housing, order 016-0296-00 ..... $50

U.S. Sales Prices FOB Beaverton, Oregon

324 10-MHz Oscilloscope

SONY/TEKTRONIX

- 2 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- AC, DC or BATTERY POWERED
- COMPACT SIZE—WEIGHT ≈8 lb
- 8-MHz BANDWIDTH at 2 mV/DIV
- DESIGNED for SEVERE ENVIRONMENTS
- CONVENIENT ACCESSORY STORAGE



The 324 is an all solid-state, single-channel, 10-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 324 features small size and light weight, together with low power consumption. Depth is 10.6 inches, width— 8.5 inches, height— 4.3 inches, weight— ≈8 pounds. Power consumption is only 8.5 watts from an external DC source and 20 watts when powered from the AC line. Internal rechargeable batteries will provide up to 3 hours continuous operation. The portability/performance provided by the 324 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications such as industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 10 MHz at 3-dB down. DC to at least 8 MHz at 3-dB down using X5 gain. Low-frequency 3-dB-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime— 36 ns or less; 45 ns or less using X5 gain.

Deflection Factor— 10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 2 mV/div to 4 V/div using X5 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to approx 50 V/div.

Input R and C— 1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage— 500 V (DC + peak AC).

HORIZONTAL DEFLECTION

Time Base—1 μs/div to 0.2 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.1 s/div; accurate within 4% at 1 μs/div, 2 μs/div and 0.2 s/div. Uncalibrated, continuously variable between steps and to approx 0.5 s/div.

X5 Magnifier—Operates over full time base, increases fastest sweep rate to 0.2 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 1 μs/div to 20 ms/div, within 5% at 0.2 μs/div, 0.4 μs/div, and 40 ms/div.

External Input—Continuously variable from approx 25 mV/div to approx 2.5 V/div, AC or DC coupled. DC to at least 200 kHz at 3-dB down.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300-V maximum input voltage (combined DC + peak AC).

Amplitude Requirements— 0.3-div deflection or 100 mV external to 1.5 MHz, increasing to 1-div deflection or 500 mV external at 10 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 15 kHz with AC LF REJ coupling.

CRT

CRT— 6 x 10-div display area; each div is 1/4 inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major 1/4 inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −55°C to +75°C (without batteries). -40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 15,000 feet maximum. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, 1/2 sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of MIL-Std-202C, Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity).

OTHER CHARACTERISTICS

Amplitude Calibrator— 0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probe—The P6049A is a miniaturized 10X probe with 3.5 foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: Removable power pack contains 6 size "C" NiCd cells providing 1 to 3 hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: Operates from an external DC source of 6.5 V to 16 V, requires up to 8.5 W.

External AC source: Operates from an external AC source of 115 V ±10%, or 230 V ±10%. 48 to 440 Hz, 20 W maximum at 126 VAC.

Dimensions and Weights—

Height with accessory pouch	4.3 in	10.8 cm
Width with handle	8.5 in	21.6 cm
Width with AC power cord	9.3 in	23.5 cm
Depth, handle not extended	10.6 in	27.0 cm
Depth, handle extended	12.8 in	32.4 cm
Net weight without accessories	8 lb	3.6 kg
Domestic shipping weight	≈14 lb	≈6.4 kg
Export-packed weight	≈22 lb	≈10.0 kg

Included Accessories—P6049A 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00).

Order 324 OSCILLOSCOPE, including power pack **$1225**

The SONY®/TEKTRONIX® 324 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 324 is available from Tektronix,Inc., its marketing subsidiaries and distributors.

PORTABLE TIME DOMAIN REFLECTOMETER

The 324, when packaged with a 1501 Time Domain Reflectometer (TDR), becomes a portable unit used to detect and locate faults and to measure impedance variations in transmission cables out to 10,000 feet through the use of test pulses. Resultant reflections from any discontinuities indicate the seriousness and character of the faults. The 1501 TDR is designed for use wherever transmission or power cable systems are used, whether it be in-plant, or in the field, above or below ground.

The 1501 is especially designed for use with a 324 battery-powered oscilloscope, but other oscilloscopes can be used. The 1501 can be used without an oscilloscope if a strip chart recorder is plugged into a center compartment in the 1501. Each strip chart is four centimeters wide by 32.5 centimeters long to allow permanent, inexpensive, high-resolution TDR plots of entire cables, or any particular portion of a cable. Notes may be handwritten on each chart.

The chart recorder in the 1501 can also be driven by the 1401A or 1401A-1 Spectrum Analyzer. Refer to the Spectrum Analyzer section of this catalog for complete specifications and ordering information for the 1501, 1401A, and 1401A-1.

OPTIONAL ACCESSORIES

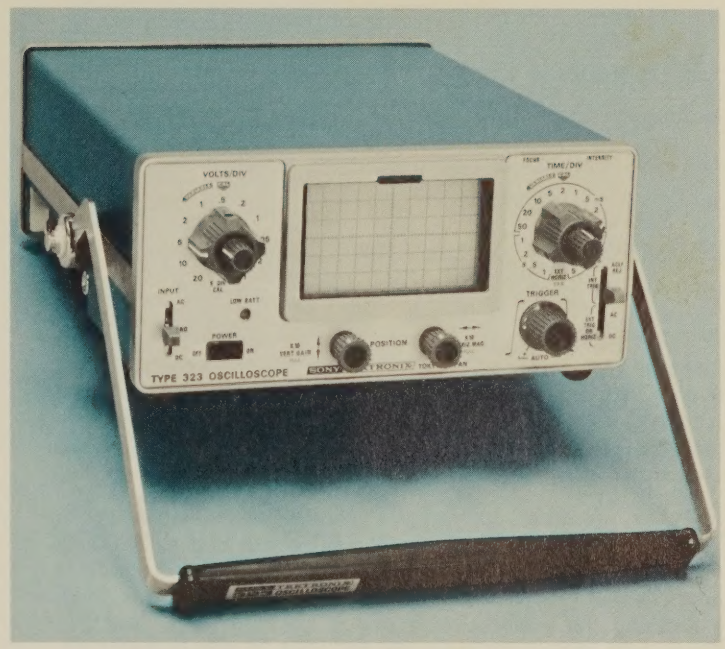
Protective Cover—The protective cover for the 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $10

Power Pack—Extra power pack, in addition to the one supplied with the 324 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0160-02 ..... $98

Battery Set—Set of 6 NiCd cells, order 146-0012-01 .... $23

U.S. Sales Prices FOB Beaverton, Oregon

- 1 mV/DIV to 20 V/DIV CALIBRATED DEFLECTION FACTORS
- AC, DC or BATTERY POWERED
- COMPACT SIZE—Weight ≈7 lb
- UP to 7 HOURS OPERATION from INTERNAL BATTERY PACK
- DESIGNED for SEVERE ENVIRONMENTS
- CONVENIENT ACCESSORY STORAGE



The 323 is an all solid-state, single-channel, 4-MHz portable oscilloscope providing the operator the convenience of using AC, DC or internal rechargeable batteries for powering the instrument. The 323 features small size and light weight, together with extremely low power consumption. Depth is 10.6 inches, width—8.5 inches, height—4.3 inches, weight—≈7 pounds. Power consumption is up to 4.5 watts, typically 1.6 watts from an external DC source and 14 watts when powered from the AC line. Internal rechargeable batteries will provide up to 7 hours continuous operation, sufficient for a full working day. The portability/performance provided by the 323 Oscilloscope, makes it most attractive for use in "on-site" maintenance applications; for example, industrial control equipment, communication systems, business machines and computers.

VERTICAL DEFLECTION

Bandwidth—DC to at least 4 MHz at 3-dB down. DC to at least 2.75 MHz at 3-dB down using X10 gain. Low-frequency 3-db-down point with AC coupling is 2 Hz or less, extending to 0.2 Hz or less with the included 10X probe.

Risetime—90 ns or less; 130 ns or less using X10 gain.

Deflection Factor—10 mV/div to 20 V/div in 11 calibrated steps (1-2-5 sequence), 1 mV/div to 2 V/div using X10 gain, all steps accurate within 3%. Uncalibrated, continuously variable between steps and to at least 50 V/div.

Input R and C—1 megohm within 2% paralleled by approx 47 pF.

Maximum Input Voltage—500 V (DC + peak AC).

HORIZONTAL DEFLECTION

Time Base—5 μs/div to 1 s/div in 17 calibrated steps (1-2-5 sequence); accurate within 3%, over the center 8 divisions, from 5 μs/div to 0.2 s/div; accurate within 4% from 0.5 s/div to 1 s/div. Uncalibrated, continuously variable between steps and to at least 2.5 s/div.

X10 Magnifier—Operates over full time base, increases fastest sweep rate to 0.5 μs/div. Accuracy of magnified display is within 4%, over the center 8 divisions, from 2 μs/div to 20 ms/div, within 5% at 0.5 μs/div, 1 μs/div, 50 ms/div, and 0.1 s/div.

External Input—Continuously variable from approx 20 mV/div to approx 30 V/div, AC or DC coupled. DC to at least 10 kHz at 3-dB down.

TRIGGER

Modes—Automatic or manual level and slope selection with a single control. Automatic operation minimizes trigger adjustments and is useful above 30 Hz. With no input, automatic triggering provides a bright baseline at all sweep rates.

Coupling—AC and AC LF REJ for internal triggering, AC and DC for external triggering. 300 V maximum input voltage (combined DC + peak AC).

Amplitude Requirements—0.3-div deflection or 75 mV external to 400 kHz, increasing to 0.75-div deflection or 190 mV external at 4 MHz. Requirements increase below 30 Hz with internal or external AC coupling and below 30 kHz with AC LF REJ coupling.

CRT

CRT—6 x 10-div display area; each div is ¼ inch. CRT uses low-power cathode, providing a useful display approx two seconds after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. Consult your Field Engineer, Representative or Distributor for application information and availability. External blanking input requires +5 V to +20 V (DC coupled), is usable from DC to at least 100 kHz. 150 V maximum input voltage (combined DC + peak AC).

Graticule—Internal, black, non-illuminated. Vertical and horizontal centerlines marked in 5 minor divisions per major ¼-inch division.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating: −15°C to +55°C. Non-operating: −55°C to +75°C (without batteries). −40°C to +60°C (with batteries). Charging: 0°C to +40°C.

Altitude—Operating: 30,000 feet; maximum ambient temperature must be decreased by 1°C/1000 feet from 15,000 feet to 30,000 feet. Non-operating: 50,000 feet.

Vibration—Operating: 15 minutes along each of the 3 major axes, 0.025 inch peak-to-peak displacement (4 g's at 55 Hz) 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and non-operating: 30 g's, ½ sine, 11-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Non-operating: Meets electrical performance specifications after exposure to 5 cycles (120 hours) of Mil-Std-202C. Method 106B (omit freezing and vibration, and allow a post-test drying period at +25°C ±5°C at 20% to 80% relative humidity.

OTHER CHARACTERISTICS

Amplitude Calibrator—0.5 V at external jack, accurate within 1% from +20°C to +30°C, within 2% throughout the operating temperature range. Output resistance approx 10 kΩ. Output also switchable internally to vertical amplifier.

Probe—The P6049 is a miniaturized 10X probe with 3.5-foot cable, and right-angle swivel BNC connector. Input R and C with probe is 10 MΩ paralleled by less than 13.5 pF.

Power Sources—Internal DC source: removable power pack contains 6 size "C" NiCd cells providing 3- to 7-hours operation. Operating time depends on signal frequency and amplitude, the setting of trace intensity, operating temperature and temperature during previous battery charge. Maximum time is achieved at 20°C to 25°C charge and 20°C to 30°C operating temperature. Internal charger provides for charging the internal batteries when connected to the AC line, operating or non-operating. Front-panel light indicates when internal batteries are low, or when external DC source is low. Recharge requires at least 16 hours at full charge. A Trickle Charge mode prevents battery self-discharge when not in use.

External DC source: operates from an external DC source of 6 V to 16 V, requires up to 4.5 W, typically 1.6 W.

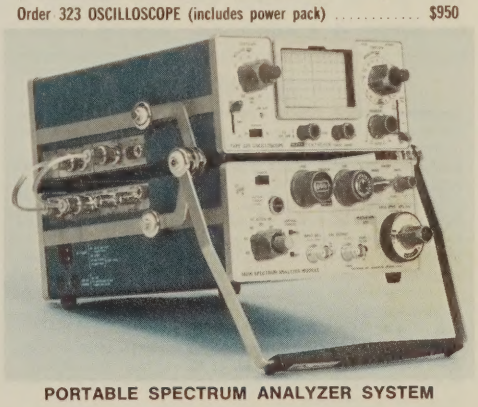
External AC source: operates from an external AC source of 90 to 136 V, or 180 to 272 V. 48 to 440 Hz, 14 W maximum at 115 VAC.

Dimensions and Weights—

Height with accessory pouch	4.3 in	10.8 cm
Width with handle	8.5 in	21.6 cm
Width with AC power cord	9.3 in	23.5 cm
Depth with handle not extended	10.6 in	27.0 cm
Depth with handle extended	13.0 in	33.0 cm
Net weight without accessories	7 lb	3.2 kg
Domestic shipping weight	≈13 lb	≈5.9 kg
Export-packed weight	≈21 lb	≈9.5 kg

Included Accessories—P6049 10X probe (010-6049-01); patch cord (012-0089-00); accessory pouch (016-0113-03); viewing hood (016-0247-01); power cord (161-0043-00); panel cover (200-0812-00); strap assembly (346-0051-00).

Order 323 OSCILLOSCOPE (includes power pack) $950



PORTABLE SPECTRUM ANALYZER SYSTEM

The 323 Oscilloscope becomes a frequency domain measurement tool when used with the Tektronix 1401A 1-to-500 MHz Spectrum Analyzer Module. AC, DC, or battery power may be used for this 15-pound system. A complete description of the 1401A and the 1401A/323 System is found in the Spectrum Analyzer section.

OPTIONAL ACCESSORIES

Protective Cover—The protective cover for the 323 or 324 can be used during transport or storage, and is constructed of waterproof blue vinyl, order 016-0112-00 ..... $10

Power Pack—Extra power pack, in addition to the one supplied with the 323 allows one power pack to charge while the other is powering the oscilloscope. Pack contains 6 size "C" NiCd cells and battery charger, order 016-0119-02 ..... $98

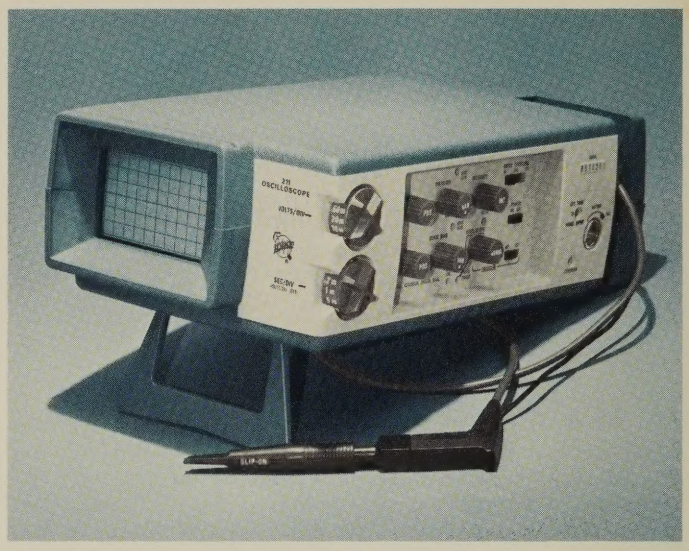
Battery Set—Set of 6 NiCd cells, order 146-0012-01 .... $23

The SONY®/TEKTRONIX® 323 is manufactured and marketed in Japan by Sony/Tektronix Corporation, Tokyo, Japan. Outside of Japan the 323 is available from Tektronix, Inc., its marketing subsidiaries and distributors.

U.S. Sales Prices FOB Beaverton, Oregon

211 *500-kHz Oscilloscope*

- **3 LB, 3 x 5¼ x 9 INCHES**
- **UP to 5 HOURS OPERATION from INTERNAL BATTERY PACK**
- **1 mV/DIV to 50 V/DIV, INTEGRAL 1 MΩ PROBE**
- **DOUBLE INSULATED**
- **DESIGNED for SEVERE ENVIRONMENTS**



The 211 is optimized for field maintenance and other applications where space and portability are primary considerations. Though small, it's complete. The 211 is the first laboratory-quality miniscope. It offers performance plus unmatched portability and carrying convenience at a lower price than many other 500-kHz scopes.

In many industrial applications, it's frequently necessary to "float" an oscilloscope. The 211 may be elevated to 700 volts above ground when operated from batteries, and 250 volts RMS above ground from AC. Caution should be observed when connecting the oscilloscope probe to the test point. The 211 meets or exceeds IEC standards for class II instruments.

The 211 is easy to use. Deflection factors from 1 millivolt to 50 volts/division, and sweep rates from 5 microseconds to 200 milliseconds/div are read out directly from the front panel, where they are related easily to the CRT display.

Trigger controls are simplified to one rotary control. A bright baseline is provided at all sweep rates, even with no signal in. When a signal is received, the oscilloscope triggers on the signal.

Some applications do require an adjustable trigger level. Turning the control clockwise causes the scope to trigger on the positive slope of the triggering waveform. Rotating the control further clockwise causes the scope to trigger on the negative slope of the triggering waveform.

The 211 is equipped with an integral flip stand which tilts the scope to a convenient viewing angle for bench-top operation. The integral probe and power cord wrap around a recessed area in the case. They are out of the way, and the user knows exactly where they'll be when he reaches the next job.

An oscilloscope used in maintenance applications should be ready to travel when needed. This means that it has to be easy to service, to eliminate the purchase of back-up scopes. The 211 disassembles quickly and easily into its modular components for access to internal components.

The 211 covers an extremely wide range of applications including industrial controls, mobile electronic facilities, audio communications, telephone and military applications, office equipment, logic probing, numerical control equipment, electronic scales, motor controls, interoffice and interplant communications, avionics, marine electronics, frequency translator maintenance and others.

VERTICAL DEFLECTION

Deflection Factor— 1 mV/div to 50 V/div in 15 calibrated steps (1-2-5 sequence), accurate within 5%. Uncalibrated, continuously variable between steps and to at least 150 V/div.

Bandwidth—DC to at least 500 kHz from 10 mV/div to 50 V/div, reducing to at least 100 kHz at 1 mV/div. Lower 3-dB-down point AC coupled, is 1.6 Hz.

Input R and C—Approx 1 MΩ paralleled by approx 130 pF via permanently attached signal acquisition probe.

Insulation Voltage— 500 V RMS or 700 V (DC + peak AC) when operated from internal batteries, with the line cord stored and the plug protected. When operated from AC, line voltage plus floating voltage not to exceed 250 V RMS; or 1.4 x line + (DC + peak AC) not to exceed 350 V.

Maximum Input Voltage (probe tip to common)— 600 V (DC + peak AC), 600 V peak-to-peak AC, (5 MHz or less) from 50 V/div to 0.1 V/div; 600 V (DC + peak AC), AC not over 2 kHz from 50 mV/div to 1 mV/div.

HORIZONTAL DEFLECTION

Time Base— 5 μs/div to 200 ms/div in 15 calibrated steps (1-2-5 sequence); accurate within 5% over center 8 divisions.

Variable Magnifier—Increases each sweep rate by at least 5 times. Continuously variable magnification extends the maximum sweep rate to at least 1 μs/div.

External Horizontal Input— 1 and 10 V/div within 10%; DC to 75 kHz. Approx 0.5 MΩ paralleled by approx 30 pF. Maximum input voltage, 200 V (DC + peak AC), 200 V P-P AC, referenced to probe common.

TRIGGER

Modes—Internal, triggers on signals of at least 0.2 division from two hertz to 500 kilohertz. External, triggers on signals of 1 volt to 20 volts from DC to 500 kilohertz. Sweep free-runs in absence of trigger signal or for trigger-repetition rates below seven hertz in the auto preset mode. Normal mode of triggering is obtained when level slope knob is rotated out of the auto preset position. Maximum usable external input voltage, 20 volts (DC + peak AC), 20 V P-P AC, referenced to probe common.

CRT

CRT— 6 x 10-div display area; each div is approx 0.2 inch. CRT uses low-power cathode, providing a useful display approx one second after turn-on. P31 phosphor normally supplied; P7 is optional without extra charge. 1-kV accelerating potential.

Graticule—Internal, black, nonilluminated.

ENVIRONMENTAL CAPABILITIES

Ambient Temperature—Operating, −15°C to +55°C. Charging, 0°C to +40°C. Storage, −40°C to +60°C.

Altitude—Operating: 25,000 feet; maximum ambient temperature rating is decreased by 1°C/1000 feet above 15,000 feet. Nonoperating, 50,000 feet.

Vibration—Operating and nonoperating: 15 minutes along each of the 3 major axes at a total displacement of 0.025 inch P-P (4 g's at 55 Hz) with frequency varied from 10 to 55 to 10 Hz in 1-minute cycles.

Shock—Operating and nonoperating: 150 g's, ½ sine, 2-ms duration, 2 shocks per axis in each direction for a total of 12 shocks.

Humidity—Operating and storage: 5 cycles (120 hours) to 95% relative humidity referenced to MIL-E-16400F.

OTHER CHARACTERISTICS

Power Sources—Internal DC source contains 10 size "AA" NiCd cells provide up to 5 hours operation. Operating time depends on trace intensity, operating temperature and temperature during previous battery charge. Maximum operating time is achieved at +20°C to +30°C charge and operating temperature. Internal charger provides for charging the batteries when connected to the AC line with the instrument turned off. A battery meter indicates full charge at 15 volts and discharged at 10 volts. DC operation is automatically interrupted when battery charge drops to 10 volts to protect batteries against deep discharge. Full recharge requires approximately 16 hours. Extended time charges won't damage the batteries.

External AC source, 110 to 126 V, 58 to 62 Hz, 2 W maximum at 126 VAC. Can be operated between 104 and 110 volts with resulting slow discharge of internal batteries. Power options are shown below.

Dimensions and Weights

Height	3.0 in	7.6 cm
Width	5.3 in	13.3 cm
Depth	8.9 in	22.6 cm
Net weight without accessories	3.0 lb	1.4 kg
Domestic shipping weight	≈7.5 lb	≈3.4 kg
Export-packed weight	≈12.0 lb	≈5.4 kg

Included Accessories—Viewing hood (016-0199-00); carrying case (016-0512-00); instruction manual (070-1160-00); operator's handbook (070-1163-00).

Order 211 OSCILLOSCOPE, includes batteries $545

POWER OPTIONS

Option 1 for 220 to 250 V, 50 Hz, includes batteries $545

Option 2 for 90 to 110 V, 50 Hz includes batteries $545

OPTIONAL ACCESSORIES

10X Attenuator Package—Includes: 10X Attenuator (010-0378-00); pincher tip (013-0071-00); flex tip (206-0060-00); bannana tip (134-0013-00); IC tip adapter (206-0203-00).

Order 010-0378-01 ..... $25

Alligator Clip Kit—Includes: Adapter 6-32 to probe (103-0051-00); red clip (015-0229-00); yellow clip (015-0230-00).

Order 015-0231-00 ..... $5

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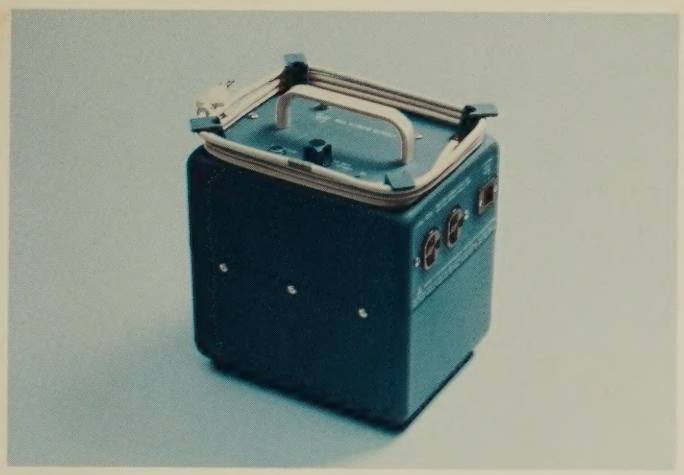
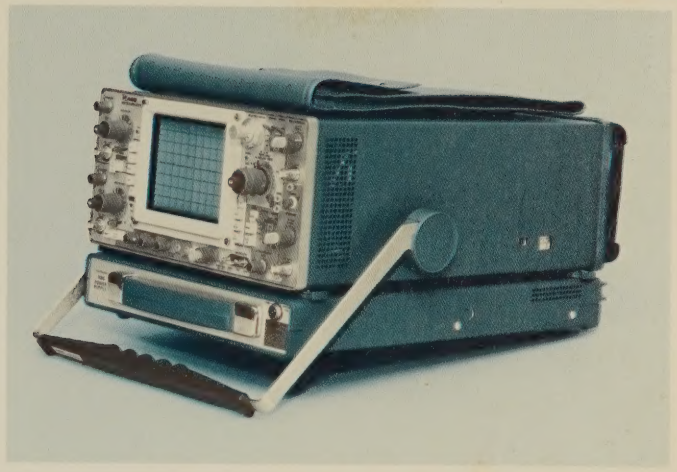
Battery Power Supply 1105 NEW
Battery Power Supply 1106 NEW





The 1105 is a NEW TEKTRONIX Rechargeable Battery Power Supply. It furnishes 108 to 137.5 VAC, 60 Hz squarewave at a 140 watt/hour rate. The 20 Type F nickel cadmium cells are rechargeable from 90 to 132 VAC (220 VAC with Option 1), 50 to 60 Hz and 24 to 30 VDC. Internal sensing circuitry automatically switches the charge rate to trickle charge when the batteries are fully charged and reduces the possibility of battery damage by preventing deep discharge.

The application possibilities of the 1105 are not confined to scopes. It can be used to power any device or combination of devices that will operate from a 115 VAC, 60 Hz squarewave at up to 140 watts. It is no longer necessary to make the portable/non-portable decision at initial purchase.

With the 1105 Battery Power Supply, the necessity to carry the dead weight of an instrument's internal power pack to locations where ample commercial power is available is eliminated. Noisy or poorly regulated commercial power can be avoided. Since instrumentation with built-in battery capability is typically more expensive than those without, the 1105 will reduce overall cost.

The 1106 Battery Pack permits freedom to operate your Tektronix 465 or 475 Option 7 oscilloscope at remote locations or when isolation from the line or ground is required. It supplies 24 V DC at a 140 watt hour capacity. For compactness, it can be connected to the feet of the 465 or 475 (as pictured above) or it can be operated and/or carried separately in two packages of almost equal weight, each with its own handle. Because the 1106 can easily be disconnected from the scope and it has an internal battery charger, the scope can be operated on external AC or DC or from a second 1106 while the batteries are being recharged.

SPECIFICATIONS

1105 *Battery Power Supply*

POWER OUTPUT

Output Waveform—Squarewave

Frequency— 60 Hz within 10%

Amplitude— 0 volts to approximately 108 volts when operating from a 24 VDC external source or 22 volts internal charge, with a 0.9 A load. 0 volts to 137.5 volts when operating from a 28 VDC external source or 30 volts internal charge, with a 0.9 A load.

Battery Operating Time—Approximately 140 watt/hours from fully charged internal batteries.

Recommended Max Output Current (0°C to +40°C)— 0.9 amp.

POWER SOURCE (Charging)

AC Requirements— 100 to 132 VAC, 50 to 60 Hz. 90 to 120 VAC, 180 to 240 VAC or 200 to 264 VAC with internal connection change.

Power Source (External DC Operating)— 24 to 30 volts. Maximum elevation for + or — power lead is 60 V with respect to chassis ground.

Power Consumption—Approximately 35 watts

Battery Charging Time— 14 to 16 hours

ENVIRONMENTAL CAPABILITIES

Temperature—Operating (0°C to +40°C). Nonoperating, with batteries, (—40°C to +60°C); without batteries, (—55°C to +75°C).

OTHER CHARACTERISTICS

Dimensions and Weights

Height	9.8 in	24.9 cm
Width	6.5 in	16.5 cm
Depth	8.3 in	21.0 cm
Weight	19.4 lb	8.8 kg
Domestic Shipping Weight	≈21.4 lb	≈9.7 kg
Export Packed Weight	≈28.4 lb	≈12.9 kg

Included Accessory—Power cord, external DC (161-0094-00).

Order 1105 Battery Power Supply **$475**

1105 OPTION 1 (220 V)

1105 Option 1 specifications are the same as above except as follows:

POWER OUTPUT

Amplitude—Approximately 216 volts 0 to peak from 22 volts internal battery charge or 24 volts external DC source, with 0.45 A load. Approximately 275 volts 0 to peak from 28 volts internal battery charge or 30 volts external DC source, with 0.45 A load.

POWER SOURCE (Charging)

AC Requirements— 200 to 264 VAC. 50 to 60 Hz. 180 to 240 with internal connection change.

Order 1105 OPTION 1 (230 V operation) **$475**

1106 *Battery Power Supply*

POWER OUTPUT

Output— 22 to 24 volts DC

Battery Operating Time— 140 watt hours from fully charged internal batteries.

POWER SOURCE (Charging)

AC Requirements— 90 to 132 VAC, 50 to 400 Hz or 180 to 264 VAC, 50 to 400 Hz.

Power Consumption— 60 watts maximum.

Battery Charging Time— 14 to 16 hours.

ENVIRONMENTAL CAPABILITIES

Temperature—Operating (0°C to +55°C). Nonoperating, with batteries, (—40°C to +60°C); without batteries, (—55°C to +75°C).

OTHER CHARACTERISTICS

Dimensions and Weight

Height	2.3 in	5.8 cm
Width	12.9 in	32.7 cm
Depth	17.0 in	43.2 cm
Net Weight	16.4 lb	7.4 kg
Domestic Shipping Weight	19.4 lb	8.8 kg
Export Packed Weight	26.4 lb	12.0 kg

Included Accessory—Power Cord (IEC female, NEC male) (161-0066-00).

Order 1106 Battery Pack **$250**

U.S. Sales Prices FOB Beaverton, Oregon

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